U–Pb chronology and REE geochemistry of large zircons in Estherville mesosiderite

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Mesosiderites are breccias composed of almost equal proportions of silicates and Fe-Ni metal. The oxygen isotopic compositions of the silicate parts of mesosiderites and HED (howardite, eucrite, and diogenite) meteorites indicate that their parent bodies are same or located in the same region [1]. However, an origin and formation histories of mesosiderites are still enigmatic, because they have experienced complex metamorphism [2]. In this study, we report results of *in situ* analyses of large zircons found in Estherville mesosiderite.

An electron probe micro-analyser was used to identify a zircon by elemental mappings of Zr and Si and for quantitative analysis of major elements. Crystallinity and structure of zircons were evaluated by Raman spectra and cathodoluminecence (CL) images, respectively. U–Pb isotopes and rare earth elements (REE) contents were analyzed using a sensitive high resolution ion micro-probe (SHRIMP).

Two large zircons, 30 × 100 µm and 100 × 300 µm, were found. The CL images and Raman spectra indicate that the larger zircon consists of several domains. U and REE contents of the most part of the zircons are quite low compared with those in basaltic eucrites [3, 4]. However, the larger zircon has U- and REE-enriched area where U and REE contents are well consistent with those in basaltic eucrites. The ^{207}Pb–^{206}Pb age of the U- and REE-enriched area is 4520 ± 14 Ma (2σ, n = 3), which is younger than zircons in basaltic eucrites [3] and Vaca Muerta (mesosiderite) [5]. These results suggest that the original zircons in Estherville were similar to those in basaltic eucrites and could have recrystallized and overgrown during the metal-silicate mixing event.

[1] Clayton and Mayeda (1996) *GCA* **60**, 1999–2017. [2] Wadhwa *et al* (2003) *GCA* **67**, 5047–5069. [3] Misawa *et al* (2005) *GCA* **69,** 5847–5861. [4] Haba *et al* (2013) *LPSC* **44,** #1989. [5] Ireland and Wlotzka (1992) *EPSL* **109,** 1–10.

Oxygen transfer across the capillary fringe: Impact of transient flow conditions and coarse-material lenses

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We performed quasi 2-D flow-through experiments at the laboratory bench-scale to investigate the impact of transient flow conditions and a coarse-material inclusion on oxygen transfer from the unsaturated zone, across the capillary fringe (CF), to anoxic water. The experimental setup consists of a flow-through chamber with inner dimensions of 80 cm × 40 cm × 0.5 cm (Fig. 1). Glass beads with two different ranges in grain diameter were used as porous media. We applied a non-invasive optode technique to measure high-resolution vertical O_2-concentration profiles across the CF at several distances from the inlet of the flow-through chamber. In addition, the oxygen flux at the inlet and in the effluent of the flow-through chamber was monitored over time.

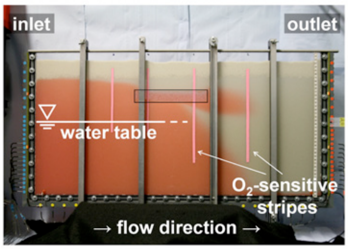

Figure 1. Experimental setup with coarse-material inclusion. The red dye (New Coccine) was used to visualize the flow field.

In homogeneous porous material, we quantified the effect of different water table dynamics, i.e., slow and fast water table fluctuations, on oxygen transfer. Enhanced O_2-supply was observed in case of slow fluctuations due to pronounced partitioning from entrapped air. In case of a fast draining water table the effect of specific yield has to be considered. The experiments performed in the heterogeneous system showed that oxygen transfer was significantly increased by the coarse-material inclusion due to flow focusing, the capillary barrier effect, and the presence of an air passage. These processes contributed to the overall enhancement of O_2-transfer through the CF to the underlying anoxic groundwater up to seven times compared to what was observed in the homogeneous experimental setup.

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